Patent Office
Canberra

I, JULIE BILLINGSLEY, TEAM LEADER EXAMINATION SUPPORT AND SALES hereby certify that annexed is a true copy of the Provisional specification in connection with Application No. 2003901311 for a patent by GEORGE WESTON FOODS LIMITED as filed on 21 March 2003.

WITNESS my hand this
Twenty-ninth day of March 2004

J. Billingsley

JULIE BILLINGSLEY
TEAM LEADER EXAMINATION
SUPPORT AND SALES

Our Ref: 7778851

P/00/009
Regulation 3:2

AUSTRALIA

Patents Act 1990

PROVISIONAL SPECIFICATION

Applicant(s): George Weston Foods Limited
821 Pacific Highway
Chatswood New South Wales 2067
Australia

Address for Service: DAVIES COLLISON CAVE
Patent & Trade Mark Attorneys
Level 10, 10 Barrack Street
SYDNEY NSW 2000

Invention Title: **Coating compositions**

The invention is described in the following statement:

COATING COMPOSITIONS

Field of the Invention

This invention is directed to coating compositions, in particular paper coating compositions, processes for the production of paper coating compositions, and treated paper.

Background of the Invention

Paper may be strengthened by means of adding strength agents in the paper making process, for example into the furnish at what is known as the wet end of a paper machine or as a coating at the size press unit or coater, which is situated at the dry end of the paper machine. Various types of starches are used in both applications, viz: cationic or amphoteric starches for wet end addition and oxidised or acid modified starches at the size press. Another means of adding starch to strengthen paper is to spray a starch slurry between the plys on multiwire paper machines. Casein and/or latexes have also been used at the coating end of the machine particularly in conjunction with pigments to improve opacity, whiteness and strength.

It has been proposed to use modified corn or wheat starch as a sizing agent in paper production, as a strength additive. In these proposals, corn or wheat starch is cooked with an oxidant such as ammonium persulphate under acid conditions to reduce the viscosity of the starch to enable smooth pickup and impregnation of the paper. The resulting starch suffers from performance problems, including poor strength properties when applied to paper.

Wheat flour has also been proposed for use as an additive at the beginning stages of paper production, particularly addition to wet pulp in the uncooked form. Retention of flour in these proposals was often less than 60% w/w, which was uneconomic.

It has also been proposed to use cooked flour at the sizing step of manufacture of paper. However, the insoluble gluten results in fouling of the paper production equipment. A

further problem with these proposals is that the gluten content causes a gummy finish in the resultant paper.

A large number of different types of paper size compositions have been developed in attempts to increase the strength and durability of paper, and to improve printability, opacity and whiteness. For example, US Patents Nos. 5,122,568 and 5,139,614 teach the use of styrene acrylic copolymers for enhancing sizing and ink print contrast. US Patent No. 3,562,102 discloses amine reaction products of alkyl glycidyl mixed esters for use in sizing paper substrates. US Patent No. 4,294,704 describes paper and paper board coating compositions which contain aqueous latex binders of synthetic polymers, such as styrene-butadiene copolymers, carboxyl styrene-butadiene copolymers and the like in order to provide improved dry and wet tear resistance. US Patent No. 6,494,990 describes coating compositions based on hydrophilic polyacrylimides and various copolymers. Issues of expense and health concerns of such compositions arise. For example, polyacrylimides have been associated with neurotoxicity.

There remains a need for low cost, high performance, non-noxious paper coating compositions.

This invention has particular applicability to the end stages of paper production, for example the size press coating stage. Coating compositions also find use as adhesives. This invention thus has application in the adhesive field, for example in gummed tape manufacture, and as an additive to gypsum board to improve bonding of the liner to the gypsum core.

Summary of the Invention

Surprisingly, it has been found that alkali oxidation of starch/protein mixtures followed by cooking and viscosity reduction gives rise to highly advantageous coating compositions, having particular application as paper coatings. These coatings have been found to increase the strength and durability of paper.

In accordance with a first aspect of this invention there is provided a coating composition which comprises an alkali oxidised aqueous starch/protein mixture having a viscosity between about 1 and about 100 centapoise (cps). Preferably the composition may be used to treat paper, for example as a paper size or paper coating composition.

In accordance with another aspect of this invention there is provided a process for the production of a coating composition, for example a paper coating composition, which comprises the steps of:

(a) forming a mixture of a plant protein and plant starch in water, preferably having from 5 to 30% solids content;

(b) oxidising the mixture with an oxidising agent at alkaline pH; and

(c) heating the oxidised mixture at a temperature from about 70 to about 150°C until the viscosity is lowered to about 1 to 100 cps.

In accordance with a further aspect of this invention there is provided a process for increasing the strength and durability of paper which comprises applying to the surface of paper a paper coating composition which comprises an alkali oxidised starch/protein mixture having a viscosity between 1 and 100 cps.

In a still further aspect of this invention there is provided an adhesive composition which comprises an alkali oxidised starch/protein mixture having a viscosity between 1 and 100 cps.

Detailed Description of the Invention

Coating compositions according to the present invention may be used to treat paper, for example as a size composition. The compositions of the invention impart strength and durability to paper, and may also improve paper printability.

In its broadest aspect, this invention is concerned in a first aspect with a coating composition, in particular a paper coating composition, which comprises an alkali oxidised aqueous starch/protein mixture having a viscosity between about 1 and 100 cps.

The plant protein may comprise plant proteins from wheat, rye, sorghum, triticale, maize, oats, barley, soy, lupin, or other plant source. Plant proteins may be a mixture of one or more plant proteins. For example, the plant protein may be a zein protein from maize or plant protein from other cereals, or a mixture of plant proteins, such as soy protein components extracted from soybeans. The plant protein may comprise plant proteins extracted from plant material according to methods well known in the art.

The starch component from a mixture may comprise a plant starch from wheat, sorghum, triticale, maize, oats, barley, or rye. Any plant starch may be used in the invention, including waxy and high amylose versions of cereal plants.

Plant proteins and plant starches may be mixed together to give a mixture of plant starch and plant protein. Generally, the resulting mixture contains from 6% w/w to 20% w/w plant protein, with the remainder comprising plant starch.

Preferably, the starch/protein mixture is flour, that is flour produced by milling grain, such as cereal grains. Examples of flours which may be used in this invention include wheat flour, sorghum flour, triticale flour, maize flour, oat flour, barley flour and rye flour. Protein levels in such flours generally range from 2 to 20%.

Flour may be mixed with water to give a solids content of from about 5 to about 30% w/w. Such a mixture is generally in the form of a slurry. The slurry of flour and water can be readily oxidised using a conventional oxidising agent, for example as used in the oxidation of starch or flour, including a peroxide such as hydrogen peroxide, persulphate as ammonium persulphate or sodium hypochlorite or sodium perborate. The mixture may be agitated, for example by mixing during the oxidation. Alkali oxidation of flour/water

mixtures is not particularly temperature dependent, although a reaction temperature of 30-50 deg.C for 5-30 minutes prior to cooking will assist the oxidation process.

Oxidation of flour and water mixtures, or for that matter any plant protein and plant starch mixture in water, is carried out under alkali conditions according to this invention, for example at a pH from 8 to 13. Oxidation is carried out in the absence of metal catalysts. Oxidation of flour/water mixtures is generally not temperature dependent. It is believed that under these conditions, it is carbohydrate groups in flour, for example in starch, which undergo oxidation. The extent of oxidation itself is not critical to the invention, and oxidation is generally carried out from 5 to 150 minutes.

Alkali oxidised flour or other starch/protein mixtures may be heated so as to reduce viscosity of the aqueous compositions to about 1 to about 100 cps. For example heating at a temperature of 50 to 150°C for about 5 to about 150 minutes will reduce the viscosity of the composition to within the desired range. The alkali oxidised mixtures may be heated in a batch cooker, for example to 95°C, or via a jet cooker (up to say 140°C) whereby the starch component is reduced in viscosity to the desired level. The alkali and oxidant may also be directly injected into the flour slurry immediately prior to entering the jet cooker, so that the oxidation and heating step are carried out at the same time. Protein within the composition remains substantially in solution, and is found to enhance the strength benefit of the composition when coated onto paper.

Alkali oxidised aqueous starch/protein mixtures having a viscosity between about 1 and 100 cps have a pH generally in the range from pH 7.5 to 9.5.

The compositions may include a range of additives that can be used to facilitate protein solubility including acetates, urea, sodium benzoate, detergents, reducing agents, protease enzymes, alkalis and gums (possessing carboxylic acid end groups), eg: xanthan gum, guar gum etc).

The composition may include one or more antifoaming agents.

It may also be necessary to filter the sizing agent to remove fibre.

In accordance with another aspect of this invention there is provided a process for the production of a coating composition, for example a paper coating composition, which comprises the steps of:

(d) forming a mixture of a plant protein and plant starch in water, preferably having from 5 to 30% solids content;

(e) oxidising the mixture with an oxidising agent at alkaline pH; and

(f) heating the oxidised mixture at a temperature from about 70 to about 150°C until the viscosity is lowered to about 1 to 100 cps.

The milled grains used to produce flour include wheat, sorghum, triticale, maize, oats and barley. Protein levels in the grains may range from 2% to 20%. Flours may be produced from high or low amylose content grains, or grains having intermediate amylose content.

The coating composition of the present invention may be applied to paper or a paperboard, such as linerboard or corrugating medium, according to methods well known in the art for the application of size compositions. For example, the compositions may be utilised in a paper making machine, for example for use in as a coating at the size press unit or coater.

For the purpose of this invention, reference to paper includes all grades of paper as well as boards such as cardboard and other fibreboard.

In accordance with another aspect this invention relates to paper coated with a coating composition as herein described.

The amount of protein/starch solution applied to the paper depends on the desired strength requirements. Levels of between 2% dry coating on fibre and up to 30% dry coating on fibre may be applied, particularly if high pigment levels are present in the coating.

The alkali oxidised aqueous starch/protein mixtures having a viscosity between about 1 and 100 cps, for example where the starch/protein mixture is flour, may be used as an adhesive composition, for example in the production of adhesive tapes such as gummed tape manufacture and in other industrial uses requiring adhesive properties.

This invention will now be described with reference to the following non-limiting examples.

Examples

Test solutions of three size coatings were prepared using (a) wheat starch, (b) ASW flour (10.1% protein) and (c) HPF (high protein flour of 13.1 % protein).

(a) The wheat starch was slurried with water to give a 10 % dry solids solution and 1.0% w/w ammonium persulphate was added prior to cooking at 95°C for 10 minutes. The pH was adjusted after cooking to 5.2 with 1 N NaOH solution and the solids were checked with a refractometer (10.5%). A Brookfield viscosity was measured at 80°C (waterbath) and found to be 27.5 cps (No. 1 spindle @ 20 rpm).

(b) The ASW flour (protein = 10.1%) was slurried with water @ 40°C to give a 10-11 % dry solids mixture and 1 N NaOH solution was added to adjust the pH to 11.5.

2.6% of a 30% hydrogen peroxide solution was also added. This mixture was allowed to stand at 40°C for 30 minutes before being cooked at 95°C for 10 minutes. The solution was then placed in a waterbath at 80°C and its viscosity checked with a Brookfield viscometer and found to be 17.5 cps (No. 1 spindle @ 20 rpm). A pH determination gave a pH of 8.7 and solids were 11.0 %.

(c) The HPF (13.1 % protein flour) was prepared in the same manner as (b) above and also placed in a waterbath at 80°C. It was found to have a pH of 9.2, solids of 11.8% and a viscosity of 17.5 cps.

Paper Sample Preparation

An untreated (ie unsized) sample of corrugating medium having a basis weight of 122 gsm (grams per square metre), was cut into strips ready for coating at two application levels using two different sizes of wire wound rods. After coating with the 80°C size solutions, the paper samples were dried in an oven at 110°C for 20 minutes. The samples were then placed in a controlled atmosphere room for a further 24 hours to condition prior to being sent to a paper testing laboratory for strength testing. They were also weighed carefully to calculate the exact coating application rate. The tests performed included Burst, Concora and Ring crush. Results are shown in Table 1.

Results

To enable a viable comparison to be made, the results were recalculated in terms of percent strength increase for each one percent of coating pickup. Figs. 1, 2 and 3 show the strength gains for each type of size coating.

The results clearly demonstrate that oxidised flour is considerably more effective than oxidised wheat starch and further, that this increase improves as the protein increases in the flour.

Table 1

Paper sample No.	Rod No. Used	Percent dry coating	Coating Type	Burst Kg/sq.cm	Concora (CMT) Kgf	Ringcrush (RCT) Kgf	Comments
A1	25	8.54	Starch	2.57	-	-	
A2	25	8.25	Starch	-	18.72	13.79	
B1	10	6.36	Starch	2.32	-	-	
B2	10	7.0	Starch	-	17.34	15.96	
C1	25	8.15	ASW	2.71	-	-	
C2	25	7.76	ASW	-	19.05	16.88	
D1	10	6.0	ASW	2.16 *	-	-	Defect in one test
D2	10	6.93	ASW	-	19.23	15.30	
E1	25	7.48	HPF	2.64	-	-	
E2	25	9.1	HPF	-	19.84	15.37	
F1	10	6.86	HPF	2.55	-	-	
F2	10	7.04	HPF	-	13.87 *	18.26 *	One test only (defect)
G	0	0	-	1.66	14.45	10.62	

RCT (Ring Crush) (percent increase in RCT per percent application)
Kgf

Starch	ASW Flour	HPF
5.4	7.0	7.56

Burst (percent increase in burst per percent application)
Kg/cm^2

Starch	ASW Flour	HPF
6.34	7.76	7.96

Throughout this specification and the claims which follow, unless the context requires otherwise, the word "comprise", or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated integer or step or group of integers or steps but not the exclusion of any other integer or step or group of integers or steps.

The reference to any prior art in this specification is not, and should not be taken as an acknowledgment or any form of suggestion that that prior art forms part of the common general knowledge in Australia.

DATED this 21st day of March, 2003.

George Weston Foods Limited
By Its Patent Attorneys
DAVIES COLLISON CAVE

FIG. 1

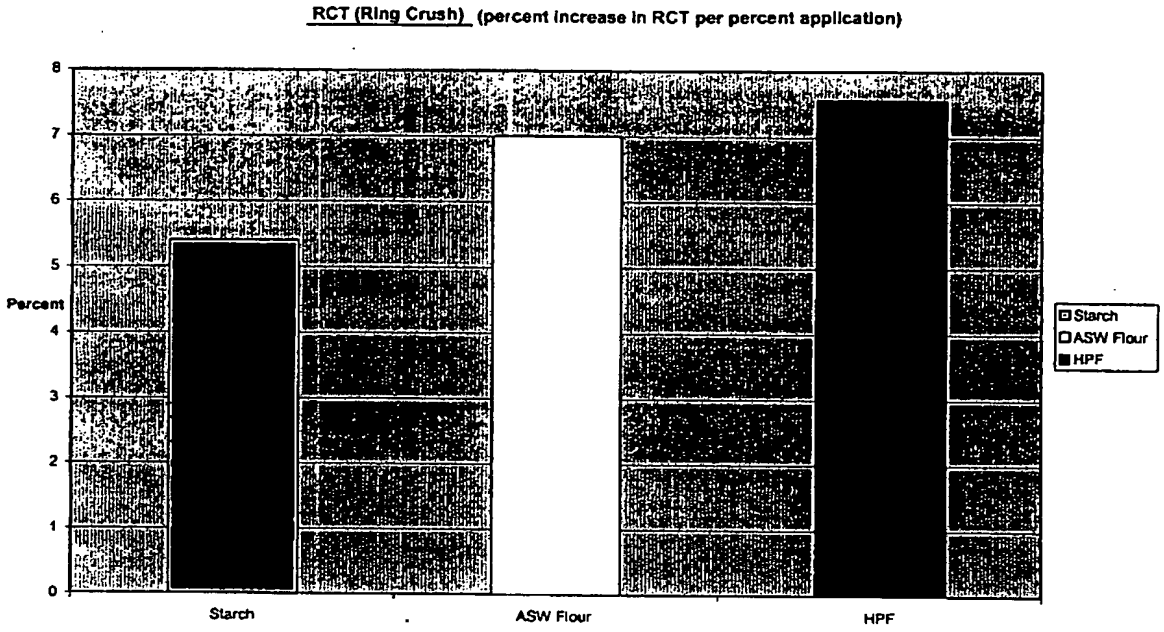

RCT (Ring Crush) (percent increase in RCT per percent application)
Percent
0
1
2
3
4
5
6
7
8
Starch
ASW Flour
HPF
Starch
ASW Flour
HPF

FIG.2

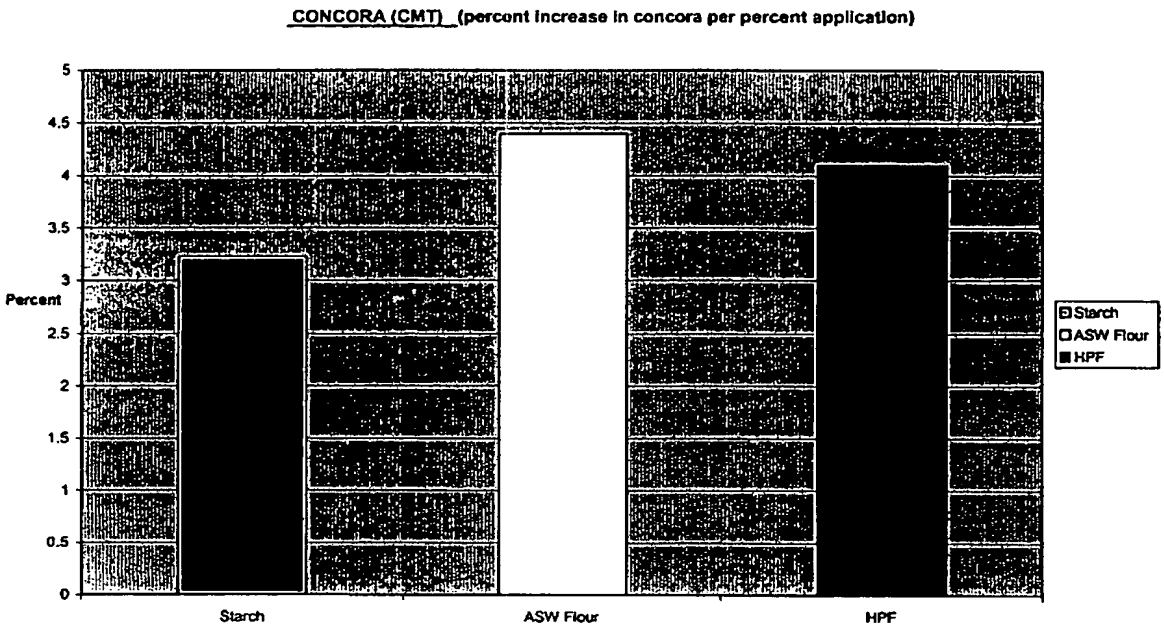
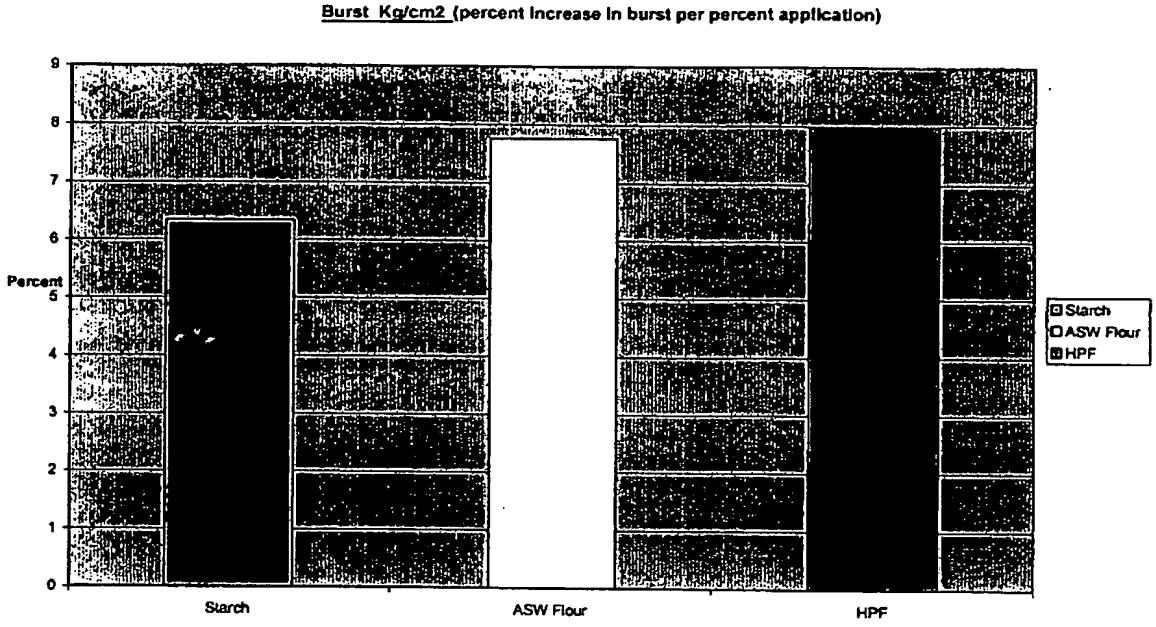

CONCORA (CMT) (percent increase in concora per percent application)
Percent
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Starch
ASW Flour
HPF
Starch
ASW Flour
HPF

FIG. 3


Burst Kg/cm2 (percent increase in burst per percent application)
Percent
0
1
2
3
4
5
6
7
8
9
Starch
ASW Flour
HPF
Starch
ASW Flour
HPF